Science Data Understanding for Autonomous Rover Exploration

Completed Technology Project (2012 - 2016)

Project Introduction

Autonomous rover traversal speed and capabilities are rapidly increasing, but communications bandwidth for planetary exploration remains limited. In order to maximize the scientific return of exploration robotics, techniques must be developed that enable rovers to build a world view that allows them to recognize anomalies and make navigation decisions based on expected science yield. Rovers will need to be able to navigate beyond their visible horizon, make observations without human oversight, and develop their own understanding of the world in order to accurately and successfully explore autonomously. This proposed research will create methods and algorithms for rovers to assemble an integrated model of their environment using onboard scientific instruments. We outline a system in which the rover gradually learns from its observations, updating internal maps that describe both the physical nature of the surrounding world as well as scientific characteristics. Using this map, the rover would then be able to make intelligent decisions about whether to explore areas of low understanding or those likely to have high science yield. In order to accomplish this, we propose three main advances to the field of autonomous science. First, the rover must be able to make use of varied scientific instrument readings and merge these observations with traditional maps such as those created using stereo vision. Then, using this information, the rover will analyze data captured throughout its traversal and use variations in observations to classify distinct terrain types, such as sand dunes or solid rock. Finally, the rover will use these regional classifications and prior scientific findings to determine locations that will maximize information gain or the likelihood of scientific discovery. We further propose a system in which human input is used both for initial training and periodic corrections in order to increase the rate at which the system learns as well as minimize the error within the rover's maps. A system such as this would greatly increase the amount of autonomy possible in both planetary and terrestrial exploration missions in which human contact is limited. This work directly applies to the STR fields of Sensing Non-Geometric Terrain Properties (TA04 4.1.4), and Semi Automatic Systems (TA04 4.5.12), with related work in Planning/Scheduling Resources (TA04 4.5.4) and 3-D Path Planning with Uncertainty (TA04 4.2.4).

Anticipated Benefits

A system such as this would greatly increase the amount of autonomy possible in both planetary and terrestrial exploration missions in which human contact is limited.

Project Image Science Data Understanding for Autonomous Rover Exploration

Table of Contents

Organizational Responsibility

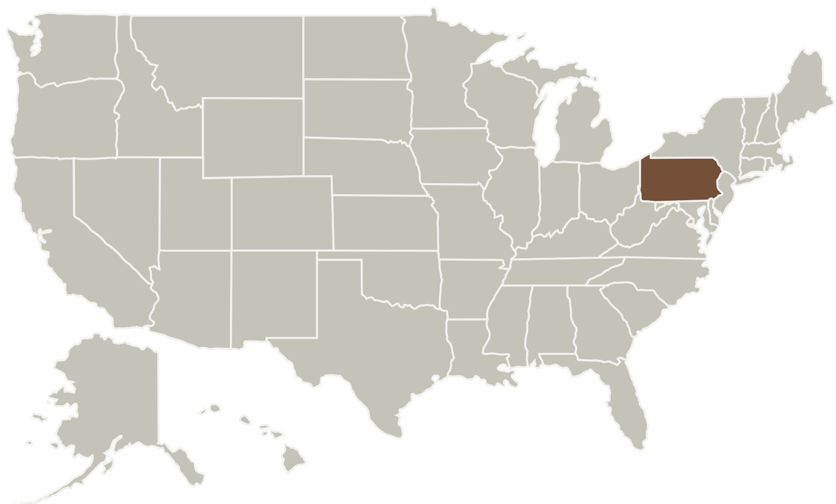
Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Space Technology Research Grants

Primary U.S. Work Locations and Key Partners



Primary U.S. Work Locations
Pennsylvania

Images

11490-1363264359720.jpg
Project Image Science Data Understanding for Autonomous Rover Exploration
(https://techport.nasa.gov/image/1819)

Project Management

Program Director:
Claudia M Meyer

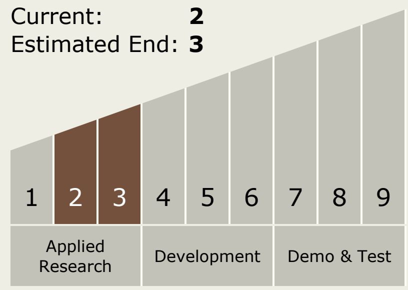
Program Manager:
Hung D Nguyen

Principal Investigator:
David Wettergreen

Co-Investigator:
Greydon Foil

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX10 Autonomous Systems
  └ TX10.1 Situational and Self Awareness
    └ TX10.1.3 Knowledge and Model Building

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html